Final Report

Coordinating noise transportation research and engineering solutions

Integrating Activity

implemented as

Coordination Action

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PUBLISHABLE FINAL ACTIVITY REPORT/ EXECUTIVE SUMMARY

The European vehicle industry is facing many challenges during the next few decades. The challenges are not only due to competition from Asia and the US but are also based on the increasing public awareness of a threatened environment . The production of greenhouse gases is of main public concern but so is also the increasing noisiness of our cities and suburbs. Road traffic is a main contributor to the production of green house gases. Rail and road traffic are dominating sources of noise in most European cities. Possible solutions to these problems have within CANTOR been discussed and investigated among representatives of some major vehicle industries and universities.

The overall aim of CANTOR is to engage experts from vehicle manufacturing industry chain and renowned research groups, jointly to focus on improved vehicle performance with a reduced impact on the environment. The means to achieve the goals are the accumulation and technology transfer of existing knowledge and information on new prediction tools, measurement techniques, research plans, material data as well as new educational programmes applied to vehicle acoustics. The aim is also the formulation of new joint research programmes between industry and universities. The mobility of personnel within the CANTOR Consortium would automatically be stimulated by the partnership.

A decreased production of greenhouse gases will force the vehicle industry to consider, develop and manufacture new types of propulsion systems. The weight problem of vehicles must also be addressed. Less weight requires less engine power. New types of noise sources, i.e. engines, and new lightweight materials will increase the demand for improved programmes or soft-wares for the prediction of exterior and interior noise from vehicles. New innovative designs must also be considered.

During the project some of the leading industries and research institutes as well as government bodies have been contacted in order to identify, for these organisations, primary problem areas. Based on the response from these contacts a strategy plan for research has been formulated.

In order to achieve the noise levels suggested by the EU in an efficient way, within a short time period, the cooperation between industry and academia must be improved. The outline of the CANTOR common research strategy can be summarised in the following:

- Short term strategy: concentrate research activities and focus on a few areas of key interest: wheel-rail interaction including non-linear tools for the modelling of friction-induced noise, tyre-road noise including performance durability, novel efficient passive solutions and optimised lightweight structural design. Specific techniques in demand, like noise source characterisation and composite materials modelling, should be improved. The partners working on these areas should build common research plans. Other partners who are not explicitly identifiable with these areas should contribute with specific inputs where such are applicable.
- Long-term base strategy: getting gradually involved into a multidisciplinary character of future long-term research and into problem-priented areas. This should include the

development of next-generation vibro-acoustic CAE tools, novel passive material technologies (new polymers, composite materials, micro-perforated plates…) and adapted active solutions integrated into multifunctional (smart sheets…) or hybrid designs (mounts, barriers...). The partners should establish links with researchers working in adjacent technical areas, starting with the identification of the overlapping technical domains and the ways the engineering data could be exchanged.

- Long-term strategy of information exchange: an Advisory Board should be maintained in the post-CANTOR period to provide valorisation of research ideas and approaches which are potentially exploitable. The present Advisory Board could serve the purpose, but it could be enlarged by representatives of companies of different profiles, e.g. sub-contractors. The communication should be simplified, but maintained on a regular basis. The closer communications with the EU Technology platforms should be established.
- Strategy of research implementation: the results of research coordination activities of CANTOR have defined the areas which are important for the stakeholders and need further research. The present consortium should pay due attention to the policy of supporting the future research through contracts. The participation of the stakeholders in the current consortium and the individual contacts of the partners with the industry should be used to pave the way for future collective research work programmes and the modes of its finance on behalf of all interested sides. Regarding the involvement of universities in short-term industrial problems which need solution in less than one year, the universities should find ways of assisting the industry which bypass the usual long-term research programmes typical of PhD work.

The results of the project can be found on the CANTOR home page www.cantor-online.net. The homepage also gives information on:

- Prediction models
- Measurement techniques
- New materials data base
- Laboratory facilities of the partners
- Course programmes at the member universities.

It is envisaged that the CANTOR consortium will continue to cooperate and that additonal information will be published on the CANTOR homepage even in the future. Information on the CANTOR network will be distributed to universities, research institutes and other organisations and industries outside the consortium. New members will be invited to publish information on the CANTOR homepage.

FINAL REPORT AND FINAL PLAN FOR USING AND DISSEMINATING THE KNOWLEDGE

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1. INTRODUCTION

Sustainable development in vehicle engineering, i.e. to save natural resources with respect to material and energy, requires lightweight, low drag design, etc. However, a strict lightweight design contradicts requirements such as low noise, safety and functionality. To reach the new goals a lasting and well defined research programme is required. In the past the noise and vibration research effort in vehicles have been considerable. Despite this, no real breakthrough regarding new solutions of noise reduction can be claimed. The main reasons for such poor results are in fragmentation of European research and the lack of lasting cooperation between universities and industries. This negative trend must be broken. Real progress can only be achieved through the cooperation between industry and universities and the formulation of a joint research strategy.

Controlling noise sources, inherently close to vehicles and urban environments, is the main priority of the project. Secondary sources of noise pollution or ride comfort will not be addressed within CANTOR.

During the first part of the project, some of the leading industries and research institutes as well as government bodies have been contacted in order to identify, for these organisations, primary problem areas. Based on the response from these contacts a strategy plan for research has been formulated.

2. BACKGROUND

The European vehicle industry is facing many challenges during the next few decades. Today one of the most pressing demands is to satisfy future environmental requirements with the reduction of greenhouse gases from air, road and ship traffic. Also, rail transport must become more successful in competing with road traffic as regards efficiency, availability and comfort. However, it is well known that rail and road traffic are dominant sources of noise in most European cities.

An increased awareness of the climate change, its causes and consequences, has lead to a strong public opinion for saving the environment. This public opinion has forced government and industries to adopt new strategies. The industry can no longer continue to produce more heavy and more fuel consuming vehicles. This trend must be interrupted.

Cars, trucks, buses, trains and ships are certainly much less noisy today than twenty years ago. However the increased number of vehicles has drastically increased the pollution from traffic. The production of greenhouse gases threatens our very existence, and it could be argued that the noise pollution just effects our sanity. Still, noise pollution is a major environmental problem in every European city.

The purpose of CANTOR is to manage cooperation between European industries to support competitiveness in the production of transport vehicles with low noise emission and a comfortable ride experience. The means are the accumulation and transfer of existing knowledge and information on vehicle acoustics between industry, governmental and university groups. The programme aims in formulating joint research programmes, joint prediction tools and measurement techniques as well as new joint educational programmes. The programme also aims at providing an instrument to facilitate cooperation between various research groups at universities, institutes and industries by offering information about research priorities and future challenges. The cooperation will help in achieving important end results faster to a reduced cost and to prevent duplication of research work and limit fragmentation of European research in the field of transportation noise.

The aims and needs of the industry within the transportation sector are not always fully understood by universities. As experienced by the industrial sector this results in unfocused research activities at the university level. The industry is seldom or never informed about ongoing research activities and the possible outcome of this work by the universities. Further, there is no real effort in coordinating various national research activities.

To address these issues the aim of this programme is to improve European-wide links in the field of vehicle acoustics applied to the production of transport vehicles. At the start of the project the following objectives were formulated:

Objective 1. Coordination with Industrial and SME partners

One important aim of CANTOR is to engage experts from vehicle manufacturing industry chain from system to component level, government agencies and renowned research groups, jointly to focus on improved performance, reliability and safety, with a reduced impact on the environment, enabling a balanced system cost and maintaining comfort in road, rail and waterborne vehicles.

Objective 2. A Catalogue of Industrial and Societal requirements

Existing and future industrial requirements in the field of vibro-acoustics will be summarized based on discussions with representatives from car, truck, bus, train and ship industries. An official report on important technical developments to meet new economical, consumer and legislative requirements will be completed. Possible future research areas could also be compiled in this deliverable according to industrial priority.

Objective 3. Information on ongoing research activities.e

All available information on research activities in vibro-acoustics with any relevance for the vehicle industry will be reported and verified with an industrial body. National, European as well as other international projects will be considered.

Objective 4. Formulation and Dissemination of a Research Strategy Agreement

Industry and universities will formulate a research strategy to meet the future demands on noise prediction and prevention in the field of vehicle acoustics. Through public dissemination a record of future common practice will be delivered.

Objective 5. Short term Exchange of Personnel

It is important to have a close personal relationship within the coordination activities. To verify needs and present day techniques, participants from a university or an industry will visit research groups for exchange of information or for a demonstration of a new potential technique. The visit could be for a few days to a week. End of visit reports will be made available to the consortium and posted on-line.

Objective 6. Marketing and Coordination of Educational programmes

All the partner universities have comprehensive courses in sound and vibration. These programmes should be used for the retraining of engineers. The programmes will be used as a platform for recruitment of graduate engineers to the vehicle industry in Europe. The various programmes and courses available will be published and summarized in a report.

Objective 7. Coordination of Advanced Short Courses

Short courses and seminars in the field of vibro-acoustics specially structured for engineers working with vehicle acoustics will be presented. The duration of a short course would be 3 to 5 days. There should be no tuition fees for the courses but the participants should pay their own travelling expenses. Representatives from the industry will be given the opportunity to make presentations on noise prediction and prevention activities for students. On-line marketing of courses will be posted.

Objective 8. Publicise Prediction Models, Measurement Techniques, and New Materials Database

In Europe and elsewhere some basic research in the field of vibro-acoustics is not directly aimed at applications for the vehicle industry. However a modification or an extension of the basic model could make the method into a useful tool for the vehicle industry. For example, currently a number of so called energy methods for the prediction of energy flow in complex structures are being developed in scientific institutions at the fore-front of scientific technology. A critical report will summarize these methods of possible use for the vehicle industry. The report will trace future development of the prediction and measurement techniques. The establishment of an up-to-date on-line database for material properties necessary for future research strategies will be created.

Objective 9. A Catalogue of Research Laboratory facilities

Most major industries have access to acoustic laboratories and modern measurement equipment. However small and medium sized enterprises (SME) employed as sub-contractors to the major industries often lack any type of laboratory facility. A publicised inventory, off-line and on-line of existing laboratories at universities and public research institutes and their capabilities could therefore greatly benefit certain subcontractors to the large industries.

Through Objectives (8) and (9) the resources necessary to perform the requirements set by the community will be transparent to industrial and scientific communities throughout Europe.

With well publicised training and short courses, Objectives (6) and (7), personnel will be able to address legislative targets. The methodologies of more efficient research in the field of vehicle noise will be addressed in dissemination and common practice period in final stages of the project, Objective (4).

3. CONTRACTORS

All partners represent universities. The partners plus responsible persons are:

1. KTH (Kungliga Tekniska Högskolan), Stockholm, Sweden
   Anders Nilsson (co-ordinator) and Andrew Peplow

2. ISVR, University of Southampton, UK
   Paolo Gardonio and David Thompson

3 KU Leuven Research and Development, Belgium
   Wim Desmet and Bert Pluymers

4 Technical University of Berlin, Germany
   B.A.T.Petersson and André Jakob

5 INSA (Institut National des Sciences Appliquee de Lyon), Lyon, France
   Goran Pavic

6 Chalmers Technical University, Göteborg, Sweden
   Wolfgang Kropp

7 Universita Degli Studi di Ferrara, Italy
   Patrizio Fausti and Paolo Bonfiglio

Staff from the seven contractors are members of the Expert Group. The fields and responsible researchers are:

1 Flow Acoustics, Mats Åbom, KTH

2 Passive Control, Anders Nilsson, KTH

3 Wheel/Track/Ground Vibration, D.Thompson, ISVR

4 Active Control, P.Gardonio, ISVR

5 Numerical Methods, Wim Desmet, KUL

6 Engine Noise, B.A.T.Petersson, TUB

7 Measurement Techniques, B.A.T.Petersson, TUB

8 Statistical Methods, Nicolas Totaro and J.L.Guyader, INSA

9 Outdoor Noise, J.Forséen, Chalmers

10 Human Response, Etienne Parizet, INSA

11 Tyre/Road Noise, Wolfgang Kropp, Chalmers

12 Interior Noise, Patrizio Fausti and Paolo Bonfiglio, University of Ferrara

4. ADVISORY BOARD

Throughout the project the Advisory Board has played a very important role. The Advisory Board is composed of top-level scientists and leaders from industrial and governmental institutions. The members are:

- Siv Leth, Bombardier Transportation, Sweden
- Ragnar Glav, Scania, Sweden
- Joachim Scheuren, Müller- BBM , Germany;
- David Storer, Centro Ricerche FIAT, Italy;
- M.Jäcker-Cüppers, Umweltbundesamt, Germany;
- Annik Blanchet, STX Europe (previously Akeryards), Saint-Nazaire, France
  Sylvain Brancherau replaced A.Blanchet 1/1/09
- Franck Poisson, SNCF, France
- Michel Tornour, LMS, Belgium

Other experts have also greatly contributed to the project and in particular to the White Paper. Some of these experts represent PSA, Renault, Volkswagen, Alstom, Wärtsilä, INRETS, Continental and transport operators and organisations like SNCF, CER, EIM, UIC, RAPT and UBA.

5. WORK PERFORMED

The result of the work has been reported in 18 deliverables. A list of the deliverables is presented in Section 6. The results as related to the objectives are:

Objective 1. Coordination with Industrial and SME Partners
Throughout the project the contact with some major industries has been very good. An extensive network has been created. The network includes industries, research organisations, government bodies and universities. After the end the project information of the project results will be sent out to SMEs and suppliers to the main industries. The information will be sent out via branch organisations to suppliers to the transportation industry.The aim is to publish information on CANTOR and the strategy plan in various types of branch journals.

Objective 2. A Catalogue of Industrial and Societal Requirements
Industrial and societal requirements are discussed in the deliverables 2.1, 2.8 and 2.9-11. The production of greenhouse gases is of main public concern but so is also the increasing

noisiness of our cities and suburbs. Road traffic is a main contributor to the production of green house gases. Rail and road traffic are dominating sources of noise in most European cities. These problems have within CANTOR been discussed among representatives of some major vehicle industries and universities.

A decreased production of greenhouse gases will force the vehicle industry to consider, develop and manufacture new types of propulsion systems. During the last year these problems have in a dramatic way forced the car industry to reconsider its future. Clearly, a lot of work is going on to improve engines. Even if the existing combustion engines can be replaced by less noisy engines like electric motors, noise would still remain a major problem as caused by the road- tyre contact. The weight problem of vehicles must also be addressed- less weight requires less engine power. The introduction of new composite materials seems to be a very slow process. One argument against the use of composite materials is the recycling problem. Instead lightweight metals are considered. However, eventually, composite materials will be introced.

New types of noise sources, i.e. engines, and new lightweight materials will increase the demand for improved programmes or soft-wares for the prediction of exterior and interior noise from vehicles. New innovative designs must also be considered.

In order to achieve the noise levels suggested by the EU in an efficient way and within a short time period, the cooperation between industry and academia must be improved. Research within the following topics should be emphasised:

i) Development of models for predicting internal and external noise from cars, trucks and trains.
ii) Determination of acoustic and dynamic properties of composite, sandwich and multi purpose materials.
iii) Characterisation of sources
iv) Description of tyre-road noise
v) Description of wheel-track noise
vi) Development of noise prediction models for ships, underwater noise included
vii) Founding of data bases for new materials
viii) Modelling of aerodynamic noise

The cooperation between universities and industry should be emphasised by means of:

i) Exchange of personnel
ii) Joint master and doctoral projects
iii) Joint research projects
iv) Sharing of laboratories
v) Courses jointly presented by universities and industries.

Objective 3. Information on Ongoing Research Activities

Devilerable D2.3 gives a catalogue of prediction tools and measurement methods as available from the partners. Detailed information is available in pdf format from the CANTOR homepage. Whenever possible references to relevant publications are given in the deliverable.

In D2.8 the main emphasis is on prediction and measurement methods for future needs. An overview in matrix form is presented. The matrix presentation shows to what degree models and measurement techniques are available. The need for more development is also indicated.

Future research needs are evaluated. The effort and time required for new development for each requirement is estimated. The evaluation also takes into account the paradigm shift envisaged witin the transportation industry to satisfy future environmental requirements. In the future research can be expected to be more problem oriented rather than on methods and tools as of today.

Objective 4. Formulation and Dissemination of a Research strategy.

The White paper on Research Strategy, D2.9-11, is based on the results of D2.1, D2.7 and D2.8. At the initial phase of the work the Expert Groups were responsible for gathering information on the needs and plans of the transport industry with respect to research activities in the field of sound and vibration. Questionaires were sent out and followed up by direct contacts. In the Green Paper opinions of the general public, as extracted from media reports, were also considered. Plans and views of some regulatory bodies were included in the Green Paper. These views were often based on very useful information obtained from the German Federal Environment Agency.

The Green Paper on the Strategy Plan was completed in December 2008 as deliverable D2.7. The plan plus an invitatation to a workshop in Paris on January the 22nd 2009 was sent out in December 2008. The invitatation was sent to all CANTOR contacts plus to members of the so called technical platforms and others as suggested by the Commission. Representatives of other EU projects like CALM, SILENCE and Q-CITY were also informed and invited to the workshop. Unfortunately the time for the meeting coincided with the worst period of the economic recession. This meant that many of those invited were, for economical reasons, not allowed to travel. However, many responded by sending mails with comments on the Green Paper.

A list of the participants at the Paris meeting is given in D1.4, Appendix A. A summary of the discussion is presented in D1.4, Appendix B. Including the comments sent by mail views on the Green Paper were expressed by the car industry (Fiat, PSA, Renault, Volkswagen), truck industry (Scania), rail industry (Bombardier, Alstom, SNCF), ship industry (STX Europe, Wärtsilä), tyre industry (Continental), research institutes (INRETS, TNO) and transport operators and organisations (SNCF, CER, EIM, UIC, RAPT, UBA). In addition there were comments by the seven university partners as well as the members of the Expert Groups.

The Green Paper was revised based on the comments by the participants at the meeting and by others as expressed by telephone or mail. The result is the White Paper, D2.9-11. The White Paper has been distributed to all CANTOR contacts plus the EU Technical Platforms representing the transport sector.

Information about CANTOR and its results has been spread by means courses, workshops and seminars to a rather large population. However the results have not directly reached the general public outside the transport sector.

It is envisaged that the CANTOR consortium will continue to cooperate and that additonal information can be published on the CANTOR homepage.

Objective 5. Short term Exchange of Personnel.
The result of the mobility programme is reported in D3.5. Despite being well advertised the programme failed completely in as much as there was no short term exchange of personnel. The industrial members of the Advisory Board considered it too expensive, considering indirect costs, to send an employee for a week or two to any universities. It was also claimed that the workload for the employees was too heavy to allow anyone to leave. A shortage of time for planning was also considered to the be the main reason why not personnel from universities were invited to industries. The general economic recession was another reason. However representatives of the partners made a number of short visits to industrial partners as reported in D3.5.

Objective 6. Marketing and Coordination of Educational programmes.
The advanced course was held at CRF, Torino, between 20/4 and 24/4/09. A first anouncement about the course was sent out in June 2008. Approximately 1000 leaflets were distributed by the partners to univerisities and industries and other organisations active in the field of transportation noise. Leaflets were also distributed at some of the major conferences on sound and vibration. A final call was sent out in February 2009. Again the number of leaflets distributed was of the order 1000. The leaflet was also distributed electronically to an additional 500 recipients. The leaflets included information on the CANTOR project with references to its homepage.

Initially the number of participants to the advanced course was, due to practical reasons, limited to 50. However the number of applications far exceeded expectations. Eventually 62 participants were accepted. The participants were from industries manufacturing cars, trucks, ships, aircraft, helicopters and even gas turbines. There were also representatives from government agencies, research institutes, consultants and universities. Students from 11 countries including India and Egypt participated. All participants were given a book on sound and vibration, published by MWL, KTH. USB memory sticks with all the presentations were also handed out.

A list of participants is presented in Appendix C, D1.4. Comments on the course by the students are summarized in Appendix D, D1.4.

It is evident that the course filled a need. It was suggested by students and teachers that this type of course should be repeated.

Objective 7. Coordination of advanced Short Courses
The activities on preparing and presenting the short courses are reported in D3.2 and D3.3. There were two short courses. The first at ISVR between the 8th and 12th of September 2008. The second was held at KU Leuven on the 18th and 19th of September 2008. The programmes for the short courses are presented in D3.2. The advanced course was held at CRF, Torino, between 20/4 and 24/4/09 as reported in D3.3 and D1.4.

Objective 8. Publicise Prediction Models, Measurement Techniques and New Materials Database.
The results of the work within CANTOR have successfully been disseminated to industries, organisations, government bodies and universities active within the transport sector.

The general public or sectors outside this realm have not been reached. However a very large number of young students at the seven partner universities have been informed. In the future these students will help to reduce community noise.

The results of the work on this objective can be found on the CANTOR home page www.cantor-online.net. The homepage also gives information on Prediction Models in D2.3 and D2.8, Measurement Techniques D2.6 and D2.8 and New Materials Data Base, D2.5.

It is envisaged that the CANTOR consortium will continue to cooperate and that additonal information will be published on the CANTOR homepage even in the future. Information on the CANTOR network will also be distributed to universities, research institutes and other organisations and industries outside the consortium. New members will be invited to publish information on CANTOR homepage.

Objective 9. A Catalogue of research Laboratory facilities.
The research facilities of partner universities are presented on the CANTOR homepage according to the format described in D2.2. The list of laboratories can be enlarged as other organisations join the CANTOR group. Information about the homepage will be distributed to potentially intersted partners.

6. DELIVERABLES

Table 1: List of Deliverables

Del. no.	Deliverable name	Workpackage no.	Date due	Actual delivery date	Lead contractor
1.1	Organisation and structure	1	1	4	KTH
1.2	First semester co-ordination progress report Web-site and News letter	1	6	7	KTH
1.3	Midterm review	1	18	31	KTH
1.4	Final plans for using and disseminating Knowledge and actions	1	30	31	KTH

2.1	Preliminary report: requirements, activities and strategies	2	4	9	KTH
2.2	Research facilities promoted on Web	2	7	9	DIUF
2.3	Report on current prediction models and techniques	2	12	14	Chalmers
2.4	Preliminary report on strategy plan	2	12	14	INSA
2.5	Framework setting up new material data base	2	18	19	DIUF
2.6	Report on measurement methods for new materials	2	24	24	DIUF
2.7	Green Paper	2	20	25	INSA
2.8	Update on relevant prediction models	2	21	29	Chalmers
2.9-11	White Paper	2	24	29	INSA
3.1	Catalogue of existing course programmes	3	12	13	ISVR
3.2	Preparation of short courses	3	18	22	KUL
3.3	Advanced course	3	24	25	KUL
3.4	Report on Existing Education Homepage	3	24	26	ISVR
3.5	Report on mobility	3	24	24	KTH

7. FINAL PLAN FOR USING AND DISSEMINATING THE KNOWLEDGE

Most of the future work is linked to the activities of the Expert Groups. These groups should remain operational after the termination of CANTOR project.

The Expert Group chairpersons have assessed the state of research in the corresponding key areas. The collected information can serve as a good starting point, but should be constantly updated and broadened. The planned extension of Expert Group activities to research bodies and stakeholders exterior to the consortium should be pursued.

A consolidated detailed list of research priority topics has been made, see Appendix of White Paper. The Expert Group chairpersons should formulate action plans and have these plans approved by the Advisory Board. This report provides a framework of future research plans. The finalised list should contain:

- a detailed schedule of urgent actions (short term plan)
- multidisciplinary research activities (long term plan)
- new research fields required by changing designs (long term plan).

The project programme addresses the key mechanisms of research sharing and dissemination: short term exchange of personnel, marketing and coordination of educational programmes, coordination of advanced short courses and publication of research results. Once the research priorities have been adopted, the collaboration and support activities need to be further elaborated. Three types of actions are of prime importance:

- modalities of research sharing between the partners
- transfer of research added value to EU stakeholders
- post-CANTOR position with respect to EU research programmes.

The first action, the research sharing between the partners, is the one which has probably the most certain outcome. The short-term exchange of personnel can be organised either via the multi-partner projects or within the current EU Marie Curie scheme.

The research transfer to the stakeholders, primarily to vehicle manufacturers and operators, is somewhat less certain. Already the Advisory Board members have identified the lack of available time and funding as the prime obstacle in fully carrying out the needed research. The dissemination of industry-friendly information via the project website will probably be a vital step toward a successful accomplishment of this action. This step is of strategic importance for the entire Coordination Action and its impact on the post-project continuation of research on transport noise.

While the CANTOR partners have expressed the willingness to accept working on presently non-covered but needed research subjects within own competence, it is clear that such an involvement has to be accompanied by an adequate support scheme in order to become realisable. The support which the research on transport noise can obtain from the EC research programmes, either during or after the end of CANTOR project, is uncertain to a great deal. Such a support should not be considered as vital to the success of the project itself. The partners should however carefully explore the means of getting future research support on the identified priority subjects if the CANTOR project is to produce any concrete impact. This action should be well elaborated before the end of the project.

The created mechanisms of information sharing using CANTOR website should remain in life after the project closure at a relatively low cost. In order to increase the efficiency of these mechanisms, a CANTOR ‘club’ could be founded. Industrial partners and stakeholders

could join at a small fee and get an active access to the partners and other members. The fee would serve to cover the running costs of the club infrastructure. The access to the club would permit asking questions, giving suggestions and using unclassified research information generated by the present and future academic partners. Discussions, meetings and presentations of new research results could be organised using widely available internet contact procedures.

8. CONCLUSIONS

The survey of research needs indicates that the whole of research activities covered by CANTOR partners are not of the same importance to the stakeholders. A few research areas should be given increased short-term priority. These areas are: wheel-rail interaction, tyre-road noise, passive noise control and advanced lightweight structural design. The short-term priority areas should be accompanied by long-term priority ones: new passive material technologies, new active and multifunctional solutions, globally optimised mechanical design by advanced computation and subjective noise perception criteria.

The survey has also shown that large industries and operators working in transport rely on university research. However, the constraints on both sides make the quality and extent of collaboration lower than desired.

The proposed strategy for EU research on transport noise is divided into four components:

- Short term strategy: concentrate research activities and focus on a few areas which were identified to be of key priority: wheel-rail interaction including friction-induced noise, tyre-road noise, novel efficient passive solutions and optimised lightweight structural design. Make full use of Expert Groups for implementing the coordination of these research areas.

- Long-term base strategy: getting gradually involved into a multidisciplinary character of future long-term research and into problem-oriented areas: next-generation vibro-acoustic CAE tools, novel passive material technologies and adapted active solutions integrated into multifunctional or hybrid designs. The links with research in adjacent technical areas should be initiated already during the project lifetime.

- Long-term strategy of information exchange: communication with stakeholders should be brought to an efficient level and maintained on a regular basis. The closer links and regular communications with the EU Technology platforms should be established.

- Strategy of research implementation: future collective research work programmes should be defined with the stakeholders including the mechanisms of supporting these programmes.

Most of the future work is linked to the activities of the Expert Groups. These groups should remain operational after the termination of CANTOR project.

The CANTOR homepage should be maintained and continously up-dated with information on prediction models, measurement techniques, data bases and courses. Advanced courses on sound and vibration should be organized regularly by industry and universities.